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## **EOS Aqua AMSR-E Sea Ice Validation Program: Meltpond2000 Flight Report**

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December 2000

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## **Abstract**

This flight report describes the field component of Meltpond2000, the first in a series of Arctic and Antarctic aircraft campaigns planned as part of NASA's Earth Observing System Aqua sea ice validation program for the Advanced Microwave Scanning Radiometer (AMSR-E). This prelaunch Arctic field campaign was carried out between June 25 and July 6, 2000, from Thule, Greenland, with the objective of quantifying the errors incurred by the AMSR-E sea ice algorithms resulting from the presence of melt ponds. A secondary objective of the mission was to develop a microwave capability to discriminate between melt ponds and seawater using low-frequency microwave radiometers. Meltpond2000 was a multiagency effort involving personnel from the Navy, NOAA, and NASA. The field component of the mission consisted of making five 8-hour flights from Thule Air Base with a Naval Air Warfare Center P-3 aircraft over portions of Baffin Bay and the Canadian Arctic. The aircraft sensors were provided and operated by the Microwave Radiometry Group of NOAA's Environmental Technology Laboratory. A Navy ice observer from the National Ice Center provided visual documentation of surface ice conditions during each of the flights. Two of the five flights were coordinated with Canadian scientists making surface measurements of melt ponds at an ice camp located near Resolute Bay, Canada. Coordination with the Canadians will provide additional information on surface characteristics and will be of great value in the interpretation of the aircraft and high-resolution satellite data sets.



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## I. Introduction

The first in a series of Arctic and Antarctic aircraft campaigns planned as part of NASA's Earth Observing System Aqua sea ice validation program for the Advanced Microwave Scanning Radiometer (AMSR-E) was successfully completed in July 2000. This prelaunch Arctic field campaign called Meltpond2000 was carried out between June 25 and July 6 from Thule, Greenland, with the objective of quantifying the errors incurred by the AMSR-E sea ice algorithms resulting from the presence of melt ponds. Melt ponds are currently the largest single source of error in the determination of Arctic sea ice concentrations with satellite passive microwave sensors. A secondary objective of the mission was to develop a microwave capability to discriminate between melt ponds and seawater using low-frequency microwave radiometers.

With the launch of Aqua scheduled for mid 2001, this campaign made use of DMSP SSM/I radiances to validate the standard AMSR-E Arctic sea ice concentration algorithm (Markus and Cavalieri, 2000). The frequencies and polarizations needed by the algorithm closely match those of the SSM/I. The overall approach to meet the validation objectives was to compare sea ice concentrations retrieved from the AMSR-E algorithm using SSM/I radiances with corresponding coincident observations from the aircraft sensors and from high resolution satellite imagery obtained from Landsat 7 ETM+, Terra MODIS, NOAA AVHRR, and RADARSAT. Determination of accuracy will be achieved by comparing the AMSR-E sea ice concentrations with independently derived concentrations from spatially and temporally coincident observations by these other sensors.

Meltpond2000 was a multiagency effort involving personnel from the Navy, NOAA, and NASA. Participants in this campaign are listed by agency in Table 1. The field component of the mission consisted of making five 8-hour flights from Thule Air Base with a Naval Air Warfare Center (NAWC) P-3 over portions of Baffin Bay and the Canadian Arctic. The aircraft sensors were provided and operated by the Microwave Radiometry Group of NOAA's Environmental Technology Laboratory. A Navy ice observer from the National Ice Center provided visual documentation of surface ice conditions during each of the flights. Two of the five flights were coordinated with Canadian scientists making surface measurements at an ice camp located near Resolute Bay, Canada. Coordination with the Canadians provided additional information on surface characteristics and will be of great value in the interpretation of the aircraft and high-resolution satellite data sets.

**Table 1. Meltpond2000 Participants**

<b><i>NASA Goddard Space Flight Center/Laboratory for Hydrospheric Processes</i></b>			
Donald J. Cavalieri	Edward J. Kim	Thorsten Markus	
<b><i>NOAA/Environmental Technology Laboratory</i></b>			
Albin J. Gasiewski	Michael McCormick	Karin Schuler	Taneil Uttal
<b><i>Naval Air Warfare Center</i></b>			
Paul Barker	Frank Cox	Miles Ervin	William Heaton
Neal C. Mars Jr.	Aaron McAtee	Leslie Miles	Lynn Mosterd
Patrick Murphy	William Rustmann	John Sandifer	Andrew Salcido
Michael Silah	Kurt Unangst	Glenn W. Wallace	William C. Walsh
<b><i>National/Navy Ice Center</i></b>			
Amy VanBuskirk			

## II. NAWC P-3 Aircraft Instrumentation

The P-3 aircraft was equipped with the NOAA Environmental Technology Laboratory (NOAA/ETL) polarimetric scanning radiometers (PSR-A and PSR-C) covering the AMSR-E range of frequencies (6.9 GHz to 89.0 GHz). Boresited with each PSR scanhead was an infrared scanning radiometer operating at 9.6-11  $\mu\text{m}$ . The aircraft also carried the NOAA/ETL scanning low frequency microwave radiometer (SLFMR) operating at 1.4 GHz. A summary of the aircraft instrumentation is given in Table 2.

**Table 2. NAWC P-3 Sensors for Meltpond2000**

NOAA/ETL Polarimetric Scanning Radiometers (PSR):
PSR-A(v, h, U, and V): 10.7, 18.7, 37.0, and 89.0 GHz
PSR-C(v, h, U, and V): 5.8-6.2, 6.3-6.7, 6.8-7.1, and 7.2-7.5 GHz
NOAA/ETL Scanning Low Frequency Microwave Radiometer (SLFMR):
1.4 GHz (v-pol.)
NOAA/ETL Infrared scanners operate in the range 9.6-11 $\mu\text{m}$ and are boresited with each PSR scanhead.
NASA GSFC Video and digital cameras

## III. NAWC P-3 Flight Summary

A summary of the regions covered, aircraft altitude, and sensors flown on each of the flights is given in Table 3. A map of the study region including the flight lines for each of the five flights is presented in Figure 1. For each of the flights, only one PSR (A or C) was flown, because of the availability of only one PSR positioner. Flights with the PSR-A on June 26 and 27 took advantage of the clear atmospheric conditions over Baffin Bay. The June 26 flight was made at an altitude of 19,000 feet. The objective here was to obtain coincident aircraft data with visible Landsat 7 and Terra MODIS data covering as many DMSP SSM/I footprints as possible. The flight on June 27, a day without Landsat 7 coverage, was flown at an altitude of 4,500 feet to provide the Navy ice observer with a better view of surface conditions while still covering several SSM/I footprints. The June 27 flight pattern was nested within the flight pattern for June 26 (Figure 1). The fifth flight on July 5 was also made over Baffin Bay, but with the PSR-C scanhead. This was done to map the ice cover with the low frequency radiometers.

The ice camp flights were made in combination with flights over Viscount Melville Sound and were flown on June 29 and 30 (Figure 1) along tracks consistent with surface measurements. The first flight over Viscount Melville Sound was made at an altitude of 5,500 feet with the PSR-A, whereas on June 30 the same region was overflown at an altitude of 15,000 feet with the PSR-C. The aircraft altitude on both of the ice camp runs was 1,000 feet. The flight logs for all of the flights are given in Appendix A.

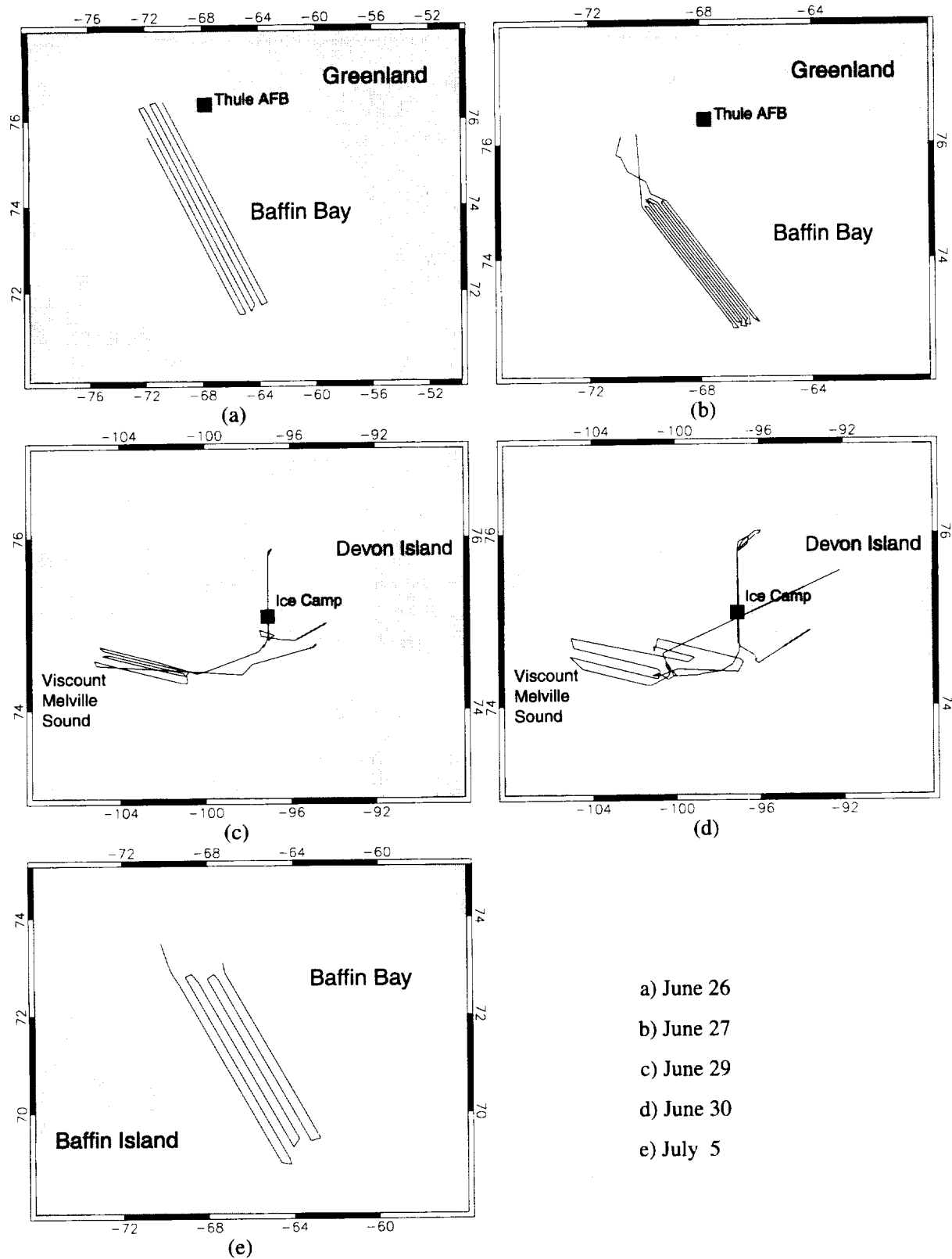


Figure 1. Meltpond2000 NAWC P-3 flight paths, June 26–July 5, 2000

Table 3. Meltpond2000 Flight Summary

Date	Region	Altitude	Sensors
June 26	Baffin Bay	19,000 ft	PSR-A, SLFMR, IR
June 27	Baffin Bay	4,500 ft	PSR-A, SLFMR, IR
June 29	V. Melville Sd. Ice Camp	5,500 ft 1,000 ft	PSR-A, SLFMR, IR PSR-A, SLFMR, IR
June 30	V. Melville Sd. Ice Camp	15,000 ft 1,000 ft	PSR-C, SLFMR, IR PSR-C, SLFMR, IR
July 5	Baffin Bay	21,000 ft	PSR-C, SLFMR, IR

#### IV. Weather and Sea Ice Conditions

Weather conditions over Baffin Bay were dominated by a high-pressure system over Greenland and so generally clear atmospheric conditions existed in the northern part of the Bay. In contrast, conditions over Viscount Melville Sound, and in the vicinity of the Canadian Ice Camp were more variable, because of an extensive low pressure system situated north and west of the Ice Camp. Poor weather conditions resulted in the cancellation of a flight west of the Canadian Archipelago on July 3. The July 4 1000-500 hPa thickness chart shown in Figure 2 is representative of the weather conditions encountered during Meltpond2000.

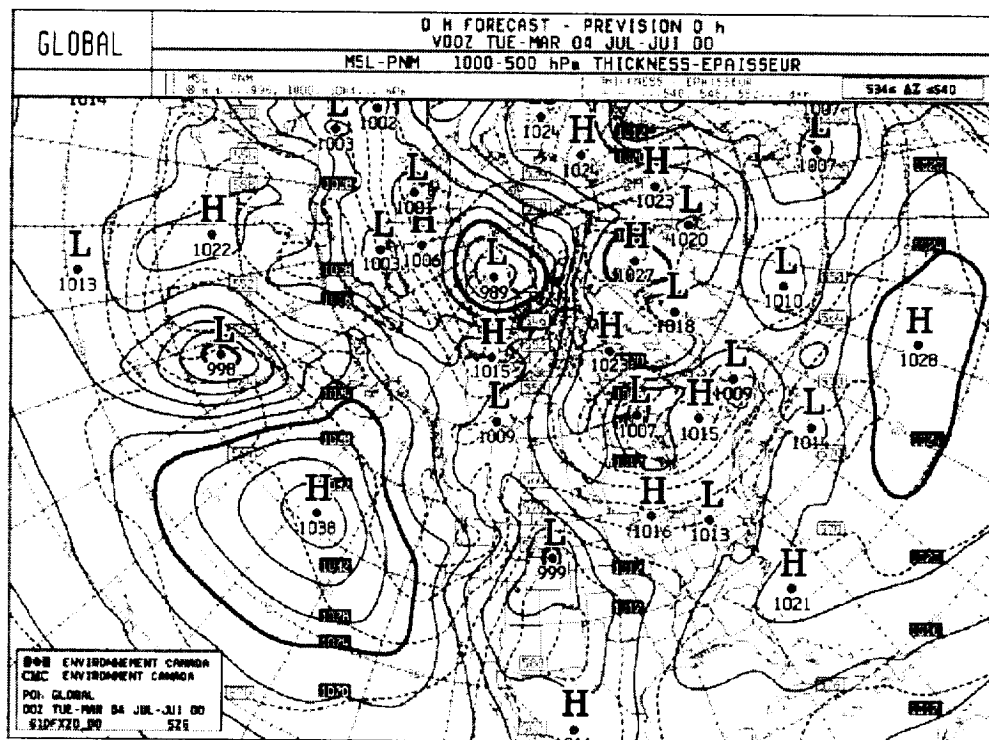


Figure 2. Canadian Weather Analysis (1000-500 hPa Thickness) Chart for July 4.

Sea ice conditions were also quite variable. Open water was present at the northern end of the Baffin Bay with ice concentrations increasing southward to 90-100%. The ice types were primarily thick and medium first-year ice with extensive surface melt ranging from ponding to rotting ice. Over Viscount Melville Sound, the meltwater appeared to be more in the form of lace than ponding. This and the numerous ridges and rough features suggested the presence of multiyear ice. In the vicinity of the ice camp, the ice was estimated to be 30-40% ponded on June 29. A large fraction of surface melt could be seen in sun glint with perhaps 10-40% surface liquid. On June 30, ponding was observed to range from 30-60% during the ice camp runs. The National Ice Center ice reconnaissance logs are provided in Appendix B.

## **V. Aircraft/Ice Camp Coordination**

A key element of this campaign was the coordination between the P-3 flights and surface measurements made by Canadian scientists as part of their study of the morphological and radiative properties of melt ponds on first-year sea ice. The Canadian research program in the Canadian Archipelago near Resolute Bay is part of the ongoing Collaborative-Interdisciplinary Cryospheric Experiment (C-ICE). Two of the five P-3 flights were dedicated to obtaining coincident measurements made at the Canadian ice camp. Flights over the camp were made on June 29 and 30 at an altitude of 1,000 feet to obtain the highest possible spatial resolution with the microwave radiometers and with the video cameras. Because of the low altitude, the sensors were operated in stare mode to provide uninterrupted measurements along the flight track. On June 29 the P-3 carried the PSR-A scanhead, whereas on June 30 the PSR-C scanhead was flown for the purpose of obtaining measurements at the full range of microwave frequencies over the two days.

During the Canadian C-ICE 2000 program, a number of different variables were collected in the vicinity of the ice camp. The data set includes standard meteorological measurements over melt ponds (air temperature, relative humidity, wind speed, incident radiation, reflected radiation) as well as pond temperatures (pond near-surface temperature, 9 cm from top of pond, and 21 cm from top of pond) and pond-ice interface flux. Measurements were logged every 15 minutes but not continuously from initial pond formation to advanced melt stages. Other measurements include photographs of melt pond evolution from initial formation to advanced stages (1 photo taken at least once per day).

## **VI. Aircraft/Satellite Coordination**

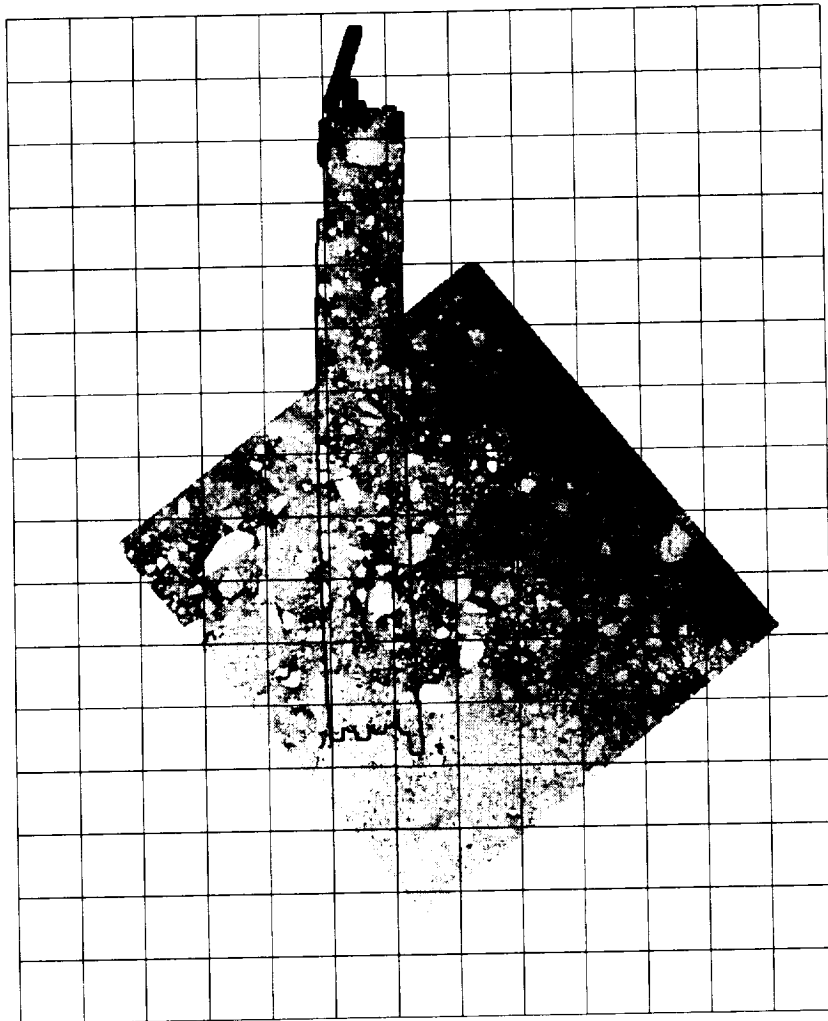
The operational DMSP SSM/I provided daily coverage of the entire study region and near real time SSM/I sea ice concentration maps were emailed to Thule in ASCII format for flight planning purposes. An ASCII character sea ice concentration map for Baffin Bay on June 27 is shown in Figure 3. Coordination with high-resolution satellite imagery was another important element in this validation campaign. Prior to our deployment to Thule, arrangements were made to acquire both Terra MODIS and RADARSAT coverage during the mission. Acquisition requests for Landsat 7 coverage were made by email within 48 hours of a planned flight. A Landsat 7 ETM+ image for June 27, a coregistered P-3 PSR-A (19 GHz, V-pol.) mosaic, and a coregistered DMSP SSM/I grid at a resolution of 25-km are shown in Figure 4.

[illegible]

280 ##8#7#####6665445#####6566#####655#####8777#####875322#####  
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335 44322000000234##432234320000025#####457#####987766532100013#####

Meltpond 2000





**Figure 4. Landsat 7 ETM+ Image of Baffin Bay with PSR brightness temperature (19 GHz, V-pol.) mosaic overlain (outlined in black) for June 27. The Landsat and PSR data are gridded at a resolution of 0.5 km. The 25-km SSM/I grid is also shown for comparison.**

## **VII. Concluding Remarks**

This report was written four months after the completion of the mission. During this time a preliminary examination of the aircraft microwave and satellite data sets was undertaken and all indications are that the mission was a success. The particularly good Landsat 7 ETM+ imagery acquired over Baffin Bay during the flights will be particularly useful in putting the aircraft data into a larger spatial context. The coordinated satellite/aircraft/surface data set acquired during Meltpond2000 is expected to serve as the basis for not only validating the AMSR-E Arctic sea ice concentrations, but for improving existing algorithms and for developing new techniques for monitoring the polar regions under summer melt conditions.

## Acknowledgements

The planning and successful completion of this mission resulted from the support received from many individuals. Of paramount importance was the help received from Dr. Elena Lobl, EOS Aqua AMSR-E Science Team Coordinator, in identifying and securing the support needed to make this mission possible. Cheryl Yuhas, Suborbital Science Branch at NASA HQ, helped negotiate the use of the Navy aircraft. Their efforts are gratefully acknowledged.

Dr. Albin J. Gasiewski, sensor scientist for Meltpond2000 and leader of the NOAA/ETL Microwave Radiometry Group, in addition to supplying all the microwave sensors, untiringly provided the leadership, technical expertise, and guidance to ensure that the requisite data were collected on each flight. Al was assisted by Michael McCormick, Karin Schuler, and Dr. Taneil Uttal.

Douglas C. Young, NASA Wallops Aircraft Office, provided substantial assistance in preparing for this campaign. His knowledge of Thule Air Base, the requirements and limitations of operating an aircraft from there, and his overall experience managing an aircraft mission resulted in the success of this campaign.

Jack Gibbons, E-O Sensor Branch, Naval Air Warfare Center, provided the coordination and integration of aircraft, sensors, and science requirements while working within the severe time constraints imposed by the mission which resulted in the aircraft making the first sea ice data flight from Thule, Greenland on schedule. Lynn Mosterd, mission manager for the Navy, and Lt. Miles Ervin, chief pilot of the Navy 150 aircraft, participated in our flight planning sessions to help insure that the science objectives for each flight were met.

Dr. Thorsten Markus, sea ice scientist, JCET/NASA GSFC, assisted with flight planning, with acquiring near real-time DMSP SSMI ice concentration maps, and with requesting the Landsat 7 ETM+ data acquisitions prior to each flight while in Thule. Dr. Edward Kim, sensor scientist, Code 975/NASA GSFC, provided overall support on each of the flights and was responsible for the acquisition of both video and digital aerial photography.

Amy VanBuskirk, AG1 ice observer with the National/Navy Ice Center, provided, in addition to the much needed visual observations, guidance with regard to weather and ice conditions during our flight planning sessions. We are also grateful to other Ice Center personnel including Cheryl Bertoia and AGC Lori Butcher for facilitating teleconferences and meetings prior to our deployment and to Mr. Paul Seymour and Ms. Anita Dungan in acquiring Radarsat imagery.

Major Brimmer, Airfield Operations, Thule AB, provided valuable guidance concerning flight operations before our deployment to Thule; Capt. Casstevens arranged for hanger and lab space on our arrival; and TSgt Larry Wilkerson provided logistical support while we were in Thule. Roger Ashley, Phil Eddy, and Jack Stephens at the Weather Operations office gave daily weather briefings and often helped with email communications.

## References

Markus, T. and D. J. Cavalieri, An enhancement of the NASA Team sea ice algorithm, *IEEE Trans. Geosci. and Remote Sensing*, 38, 1387–1398, 2000.

## **Appendix A NAWC P-3 Flight Logs**

## MELTPOND00 Experiment Log-PSR on NAWC P-3 (150)

<b>Date(s):</b>	June 26, 2000 (Julian day 178, Monday)
<b>PSR Flight Code:</b>	DF004
<b>NAVFLIR Number:</b>	
<b>T/O Location:</b>	Thule AB, Greenland
<b>T/O Time (UTC):</b>	1030 (0730 local EDT+1)
<b>Recovery Location:</b>	Thule AB, Greenland
<b>Landing Time (UTC):</b>	1905 (1605 local EDT+1)
<b>Mission Scientist(s):</b>	A. Gasiewski, E. Kim, A. Van Buskirk
<b>PSR Operator(s):</b>	A. Gasiewski, M. McCormick, E. Kim
<b>Scanhead(s):</b>	PSR/A (10.7, 18.7, 21.5, 37, 89 GHz), SLFMR
<b>Purpose of Sortie:</b>	High altitude grid over Baffin Bay for wide area imaging associated with SSMI overflights. SSMI overflight is expected around 6:00 PM local (2100 UTC). Six grids successfully flown, sky calcs not performed due to lose fuel mast and need to RTB.
<b>Synoptic Conditions:</b>	
<b>Local Site Conditions:</b>	Isobaric over grid site, some low stratus expected.
<b>Instrument Status:</b>	Normal operation during preflight: <ul style="list-style-type: none"> <li>1) IRIG-B not synchronized at scanhead</li> <li>2) Two home malfunctions during preflight, several successful afterwards during preflight. Successful conical scan operation during preflight.</li> <li>3) PSR-NAV computer not communicating over net.</li> <li>4) 10.7V (fourth Stokes) saturating during negative noise diode pulses.</li> <li>5) A/D B1, CH10,(X/Ku thermistor) shows significant crosstalk from radiometric channels.</li> <li>6) Loosened fuel mast noticed ~1730. Decision made to RTB to prevent possible loss. PSR scanhead video camera used to monitor fuel mast condition during descent and landing.</li> </ul>
<b>Operating Instruments on P3:</b>	PSR/A, SLFMR, GSFC Video
<b>Notes/Flight Synopsis:</b>	First in a back-to-back series of two imaging flights over Baffin Bay.

Time (GMT)	Event
~1100	T/O
1110	SLFMR operating normally, nav data and irig time recorded OK. Data being logged...
1112	PSR-ARCH locked up, required reboot...
1117	PSR-ARCH rebooted, acquisition started...
112000	Check_time: PSR-ARCH: 11:20:17 PSR/A Scanhead: 11:19:38 IRIGB: 11:20:00
~1148	Start line 1, heading 156.60 degrees and 19,000 pressure altitude. PSR-ARCH finally working after several reboot attempts. Several corrupted files noted. Probable cause is vibration during climbout.
125243	End line 1.
125645	Start line 2...
	Stall during line 2 - lost ~ 1.5 minutes of data.
140410	End line 2.
1409	Start line 3, heading 156.60 degrees ...
151145	End line 3.
151620	Start line 4...
162300	End line 4.
162800	Start line 5, heading 156.60 degrees...
~1715	Crossed over boundary between clear air and low (few thousand feet or so top altitude) optically thin cloud layer. The transition was not associated with any obvious changes in ice texture or cover, but is well correlated with a transition in polarization signature. The ice south of this line appears less polarized, even in the low-frequency microwave channels.  Warming of scanhead skin temperature observed during line 5 heading southward. Low cloud region at southern end of grid is apparently accompanied by an upper level warming.
172830	End Line 5.
~173330	Start line 6...
1834	End Line 6. stop scanning, Home to protect dangling fuel mast. RTB without sky calcs...
1905	Touchdown

## MELTPOND00 Experiment Log - PSR on NAWC P-3 (150)

**Date(s):** June 27, 2000 (Julian day 179, Tuesday)  
**PSR Flight Code:** DF005  
**NAVFLIR Number:**  
**T/O Location:** Thule AB, Greenland  
**T/O Time (UTC):** 1058 (0758 local EDT+1)  
**Recovery Location:** Thule AB, Greenland  
**Landing Time (UTC):** 1856 (1556 local EDT+1)  
**Mission Scientist(s):** A. Gasiewski, E. Kim, A. Van Buskirk  
**PSR Operator(s):** A. Gasiewski, M. McCormick, E. Kim  
**Scanhead(s):** PSR/A (10.7, 18.7, 21.5, 37, 89 GHz), SLFMR  
**Purpose of Sortie:** Low altitude grid over Baffin Bay for pixel intrercomparisons associated with SSMI overflights. SSMI overflight is expected around 6:00 PM local (2100 UTC).

**Synoptic Conditions:**  
**Local Site Conditions:** Isobaric high over grid site, clear below A/C entire flight, some scattered cirrus ~9,000-9,500', 3/8 to west of grid, 0/8 to north of grid. Winds mostly calm, slight N-NW component (~6 kts) at pattern altitude.

**Instrument Status:** Diagnostic notes:

- 1) Several abnormal homing occurrences during preflight.
- 2) PSR-ARCH computer was not booted in flight until nominal pattern altitude was reached and airspeed reduced. One major lockup of keyboard, ftp, and telnet occurred prior to the start of line 1. The lockup required a reboot of PSR-ARCH.
- 3) Two stalls were noted during approach to the start of the first flight line.
- 4) 10.7V (fourth Stokes) not as near saturation at -10volts as for 2000\_0626 (DF004). Video drift in this channel is apparently temperature dependent, and channel should be offset and attenuated accordingly.

**Operating Instruments on P3:** PSR/A, SLFMR, GSFC Video  
**Notes/Flight Synopsis:** Second in a back-to-back series of two imaging flights over Baffin Bay.

Observer note: Damping of waves between ice floes was easily observed through sun glint. Angular broadening of the sun was typically limited to ~10-20% of a single solar disk "diameter," as seen reflected at incident an angle of ~45 degrees. Thus, the standard deviation of the slope of the ocean was typically limited to 0.05-0.1 deg.



Occasionally, waves (associated with non-specular "rough" areas) could be seen building ~100-200 meters leeward of the floe edges. The wind direction was thus determined to be from western side of the track (~W-SW), and probably less than a few m/sec as evidenced by the small wind drift observed at flight altitude and the complete absence of whitecaps. The smooth water between floes represents a potential calibration source for PSR being that the temperature is well known (0 degC) and the water in many regions is nearly smooth by the above standards.

Several photos were taken of the sun reflecting specularly (glistening) from open water areas.

Time (GMT)	Event
1058	T/O
1106	Start_all, start psr navigation acquisition process...
1110	Comcon 53.1 15
~1115	PSR-ARCH keyboard, ftp, and telnet locked up (mouse still worked). System rebooted, resumed conical scan...
112945	Start line 1, 4,500' altitude, 210 kias...
120445	End line 1.
	Check_time PSR-ARCH: 120523 PSR/A scanhead: 120445 IRIGB time: 120510
121015	Start line 2...
124630	End line 2.
	Check_time PSR-ARCH: 124913 PSR/A scanhead: 124835 IRIGB time: 124900
125200	Start line 3...
132845	End line 3.
133445	Start line 4...
141445	End line 4.
142050	Start line 5...
145450	End line 5.
	Check_time PSR-ARCH: 145813 PSR/A scanhead: 145734 IRIGB time: 145800

[illegible]

## MELTPOND00 Experiment Log - PSR on NAWC P-3 (150)

**Date(s):** June 29, 2000 (Julian day 181, Thursday)  
**PSR Flight Code:** DF006  
**NAVFLIR Number:**  
**T/O Location:** Thule AB, Greenland  
**T/O Time (UTC):** 1100 (0800 local EDT+1)  
**Recovery Location:** Thule AB, Greenland  
**Landing Time (UTC):** 1845 (1545 local EDT+1)  
**Mission Scientist(s):** A. Gasiewski, E. Kim, A. Van Buskirk  
**PSR Operator(s):** A. Gasiewski, M. McCormick, E. Kim  
**Scanhead(s):** PSR/A (10.7, 18.7, 21.5, 37, 89 GHz), SLFMR  
**Purpose of Sortie:** Ice mapping using PSR/A over SE Melville Sound; Line plots over meltponds east of Truro Island ice camp, Canada.

### Synoptic Conditions:

### Local Site Conditions:

### Instrument Status:

Normal preflight including previously observed malfunctions:

1) PSR-ARCH photon windows locked up twice, seemed to work consistently after warmup. Lockup is observed via both keyboard and telnet, sometimes independently.

2) Scanhead home command failed on first few attempts, OK thereafter.

3) PSR scanhead video is fed to GSFC video recorder during low-altitude line plots.

4) 10.7V (fourth Stokes) and 18.7U (third Stokes) near saturation at -10v and +10v, respectively. All other channels well within range.

5) Many reboot attempts of PSR-ARCH. Failures caused by adverse impact of strong vibration on PSR-ARCH hard disk. Problem solved in flight during line 4 of the Melville grid using rubber strips under computer.

6) One SLFMR file problem: the aircraft pitch/roll file A29J0590.DAT was missing. The data from A29J0584.DAT was copied in its place to complete the sr2mat.exe operation.

### Operating Instruments on P3:

### Notes/Flight Synopsis:

PSR/A, SLFMR, GSFC Video

First of two identical flights using PSR/A scanhead. To be followed by a flight using the same maneuvers using PSR/C.

Note: Ice over Melville and ice camp areas was mostly blue, indicating absence of brine and hence fresh water ice. This ice was also mostly multiyear, as evidenced by the numerous ridges and rough features resulting from cracks. The melt water also appeared to be more in the form of a lace than a ponding, also indicative of multi-year ice. A large fraction of surface melt could be seen in sun glint, with at perhaps 10–40% surface liquid.

Time (GMT)	Event
~1100	T/O
~1130	Start_all, start psr navigation acquisition process...
1212	Comcon 52.1 15 en route @ 18,000', dropping to pattern altitude of 4,500', ~60 nmi from Resolute VOR. Over 100% blue ice cover in Wellington Channel, East of Cornwallis Island. Similar 100% cover from Cornwallis out to Melville Sound.
Note	Nadir 25 38 270 required for low-altitude lines
1234	Level off at 4,500'. Thin stratus deck below over most of Melville Sound pattern area. Climbed back up to 5,500' to stay clear of clouds.
1242	PSR-ARCH lockup. Rebooted... Comcon 53.1 15, PSR back up at 124540 for start of line 1. Undercast at ~ 4,500' below.
124730	Start line 1...
1250	Stall, reboot...
~1258	Stall, reboot again!...
	End line 1.
131000	Start line 2...
133315	Start line 3...
134520	PSR-ARCH locked up, full power-down reboot...
135110	End line 3.
	Start line 4... Major problems rebooting PSR-ARCH. Attempted to install vibration damping rubber strips under chassis. Seems to help, but disk is likely heavily corrupted.
141400	End line 4. Start line 5 shortly thereafter...
~1420	Start line 5...
~1418	PSR-ARCH (after many attempts) successfully boots. Reenter conical scan mode to finish line 5.
1438	End line 5.
1442	Start line 6...
1501	End line 6.
1505	Start line 7...
1523	End line 7.



## MELTPOND00 Experiment Log - PSR on NAWC P-3 (150)

**Date(s):** June 30, 2000 (Julian day 182, Friday)  
**PSR Flight Code:** DF007  
**NAVFLIR Number:**  
**T/O Location:** Thule AB, Greenland  
**T/O Time (UTC):** 1100 (0800 local EDT+1)  
**Recovery Location:** Thule AB, Greenland  
**Landing Time (UTC):** 1905 (1605 local EDT+1)  
**Mission Scientist(s):** A. Gasiewski, E. Kim, A. Van Buskirk  
**PSR Operator(s):** A. Gasiewski, M. McCormick, E. Kim  
**Scanhead(s):** PSR/C (6.00, 6.50, 6.925, 7.325 GHz), SLFMR  
**Purpose of Sortie:** Ice mapping using PSR/C over SE Melville Sound; line plots over meltponds east of Truro Island ice camp, Canada.  
**Synoptic Conditions:** Similar to previous flight (2000\_0629). Forecast indicates increasing cloud over or Melville Sound, perhaps also over ice camp area.  
**Local Site Conditions:**  
**Instrument Status:** Download of PSR/A scanhead and upload of PSR/C scanhead occurred without problem. Normal homing and scanning operation found on first attempt.  
  
Preflight operation of PSR/C:  
  
1) PSR/C scanhead video camera not operating. Connections at inner flange plate checked. Scanhead power and internet connections OK. Problem traced to loose TNC connector on top of inner flange plate, connector tightened, camera OK.  
  
2) PSR-ARCH keyboard locked up during several initial boot attempts. Problem may be related to temperature of computer module. Telnet access from Odysseus laptop PC was OK each time.  
  
3) Scanhead\_atod\_acq process replaced with modified version which records the system clock (as opposed to the irigb time clock). Note need to run (from root) rtc - s net 3 before acquisition in order to sync the PSR/C system clock reasonably close to the system time clock of PSR-ARCH.  
  
4) Large A/D channel crosstalk noted in some thermistor channels. Vref (A/D B1, Ch12) channel is heavily coupled to hardware trigger channel.  
  
5) Scanhead and elevation lockup at 1558 suspected to be associated with increased vibration, moisture, and/or electrification resulting from ascent through icing conditions.

**Operating Instruments on P3:**  
**Notes/Flight Synopsis:**

PSR/C, SLFMR, GSFC Video  
 Second of two identical flights, uses PSR/C.

Significantly more water coverage of ice observed during ice camp runs than yesterday. Estimate ~30-60% coverage of standing water, greater number of meltponds.

Time (GMT)	Event
~1100	T/O
~1120	Start SLFMR acquisition, 8-beam cross-track scan mode...
1127	Start all, home, from root: rtc -s net 3 to set system clock on PSR/C
1201	Comcon 55 15, Use 55 degree incidence for AMSR-E sea ice observations.
~1205	Noticed that scanhead video camera no longer functioning, probably loose TNC connector again.
1218	Stop SLFMR, restart in 3R beam stare mode for ice camp lines, 0.25 second dwell time. Begin descent to 1,000' for ice camp lines.
1220	Stop, home, nadir 60 38 270 (38 degree starboard stare, 25 second calibration intervals) to prepare for ice camp lines.
123225	Start 15° left bank turn at 1000' altitude near waypoint Sierra...
123650	End circle, line up for ice camp run #1...
124415	Begin line 1 from Sierra to November (see flight plan for 2000_0629 for waypoints)... Winds 178@11. Stratus overcast layer above A/C at ~2,000'.
1300	End line 1.
130240	Start 15° left bank turn at 1000' altitude near waypoint Sierra...Open water noted at 130255.
1307	End circle around November. Note: Mixed open water, pack ice, and floes in this circle.
131445	Start line 2 from November' to Sierra'. Stratus overcast layer above A/C at ~2,000'.
133445	End line 2. Begin line up for line 3...
133730	Start line 3 from Sierra' to November'. Stratus overcast layer above A/C at ~2,000'.
135320	End line 3.
135900	Start 15° left bank turn at 1000' altitude near waypoint Sierra over mostly open water, some floes (~10%).
140345	End circle around open water near November. Begin line up for line 4 southward.
1413	Start line 4 from November' to Sierra'. Stratus overcast layer above A/C at ~2,000'.
1429	End line 3.
1435	Begin ascent to 5,000' for Melville grid patterns.
143515	Stop, comcon 55 15, restart SLFMR acquisition in 8-beam mode, 0.5 second dwell time...
143715	Level at 5,000', PSR/C and SLFMR in scanning modes, en route to line 5 of Melville Sound grid. Note: grid has been truncated to last 4 of eight total lines to coincide with the four successful 2000_0629 lines.

1444	Weather at 5,000' over Melville Sound poor, decision made to ascend to 10,000' and cover the entire Melville sound grid, but with four lines.		
1446	Leveling off at 10,000' en route to Melville Sound grid...		
1446-1548	Climb to 15,000' to clear icing conditions, PSR elevation failed during ascent. Hard power reboot was necessary to recover control of both axes. Acquisition restarted at west end of line 1, for observations on line 2. PSR/C scanhead computer also locked up during ascent. Note that the scanhead clock was found to lagging by 12 seconds after rebooting.		
1548	Restart all acquisition and conical scanning - comcon 55 15 set_pitch 0...		
155215	Start line 2...		
1558	Broke off line 2 - discovered that grid was misplaced too far south. Repositioning grid and transiting into position to restart entire grid at line 1...		
1602	Noticed that scanhead video was functioning again.		
160930	Start line 1, 15,000' altitude...		
162500	End line 1.		
162900	Start line 2, 15,000' altitude...		
	They are going to have to scrub the Baffin Bay circles based on time constraints.		
164345	End line 2	74 23 35 latitude	100 50 63 longitude (approx)
164849	Start line 3	74 29 40 latitude	101 17 00 longitude
170510	End line 3	74 33 90 latitude	104 59 00 longitude
	Start line 4		
	End line 4		
172700	Stop, home, nadir, prepare for steep calibration rolls...		
172745	Steep sky roll #1, sky 70		
173050	Steep sky roll #2, sky 70		
173300	Steep sky roll #3, sky 70		
173330	Nadir		
1735	Comcon 55 15, RTB... Time to head for dinner.		
1738	Restart acquisition processes...		
175645	Descend. Stop, stow. stop_all_acq.		
190500	Touchdown		
	Note: scanhead_atod_acq error noted at PSR-ARCH. A/D program mixed up some channels. Five such meessages noted, time of messages unknown.		



## MELTPOND00 Experiment Log - PSR on NAWC P-3 (150)

**Date(s):** July 05, 2000 (Julian day 187, Wednesday)  
**PSR Flight Code:** DF008  
**NAVFLIR Number:**  
**T/O Location:** Thule AB, Greenland  
**T/O Time (UTC):** ~1110 (~0810 local EDT+1)  
**Recovery Location:** Thule AB, Greenland  
**Landing Time (UTC):** ~1900 (~1600 local EDT+1)  
**Mission Scientist(s):** A. Gasiewski, E. Kim, T. Uttal  
**PSR Operator(s):** A. Gasiewski, M. McCormick, E. Kim  
**Scanhead(s):** PSR/C (6.00, 6.50, 6.925, 7.32 GHz), SLFMR  
**Purpose of Sortie:** Wide area ice mapping using PSR/C over South Baffin Bay at 21,000'.  
**Synoptic Conditions:** Clear over mapping site, visibility ~50 nmi. Ice conditions ranged from open water to ~95% packed floes.  
**Local Site Conditions:** Overcast, cloud bottoms at ~2,000'.  
**Instrument Status:** Download of PSR/A scanhead and upload of PSR/C scanhead occurred 7/4/00.

### Preflight performance:

- 1) Failed fine homing operation on several attempts. Rebooted PSR-ARCH, home operation successful. Second boot has often been successful after home failure. Suspect that this problem is associated with either charge buildup in motion electronics or humidity which eventually is purged by self heating.
- 2) PSR/C scanhead video camera not functioning. Suspect problem is within scanhead since camera connector above inner flange plate was repaired and PSR/A functioned well during previous flight (2000\_0629).
- 3) Several in-flight crashes of PSR-ARCH to scanhead ethernet link. Problem apparently eliminated after A/C ground speed was reduced to ~250 kts. Suspect cause is related to vibrations that crashed PSR-ARCH on several previous flights.
- 4) Several additional malfunctions of scanhead\_atod\_acq software immediately after completing last line (#6) of grid. Several reboot attempts of both PSR-ARCH and the PSR/C scanhead computer could not bring scanhead\_atod\_acq process back up operating properly. Missed sky calibrations, otherwise, all data throughout last line is excellent.

**Operating Instruments on P3:  
Notes/Flight Synopsis:**

PSR/C scanhead immediately booted and successfully acquired data upon landing. However, the net connection failed after ~ 5 minutes of acquisition. Suspect that the scanhead PC is locking up since all functions on PSR-ARCH apparently continued. PSR/C, SLFMR, GSFC Video

Time (GMT)	Event
~1110	T/O
112730	Check_time; rtc -s net 3; Note that resetting the real time clock on PSR/C may cause the recording of two distinctly time grids - one much different from IRIGB, but short and located at the beginning of the first .rad file.
1143	Began conical scanning, comcon 55 15, scanhead_atod_acq process failed, net connection to scanhead lost. Rebooted scanhead, net connection restored, ...
114630	Second attempt to start conical scanning. Scanhead_atod_acq failed again. Rebooted scanhead computer again, this time A/C ground speed scaled back to 265.
1155	Begin conical scanning, scanhead atod process failed again. Suspect net connection. PSR-ARCH and scanhead both rebooted from power off state. Restarted nav1553_ingest, set scanhead clock, then start_all...
120245	Commence conical scanning again - third attempt after cold power boot. Suspect link failure a result of vibration again...
1211	Start line 1...
	Note: winds at altitude are 17 kts from ~000. Ice is broken, being pushed south slowly. AG1 (A. Vanuskirk) states that winds push floes at ~2% of the near-surface velocity.
1304	End line 1.

Note: viewrad images show decidedly larger v-h temperature different cover open water when looking forward versus backward. The discrepancy is up to 20K, where the average v-h difference over open water is ~80K. A smaller v-h discrepancy is also noted within regions over ice. These discrepancies were also noted in observations over the Melville Sound during 2000\_0630. The discrepancy is seen consistently in all radiometric bands.

It is noted that the aircraft is pitched up ~2.5°, thus accounting for several degrees K of increase in front-look v brightness, and several degrees K of decrease of back-look h brightness. The forward/backward brightness asymmetry is thus apparently due to pitch bias, and should be removable in processing to level 2.3.

Note: 10um IR temperature dropped from -16 to -22° C from the north end of line 1 to the southern end. Visibility is ~50 nmi, optically clear to surface. Suspect that 10umIR channel may not be functioning. Need to check all flight lines to be sure...





## **Appendix B NIC Ice Reconnaissance Data Logs**

# NIC Ice Reconnaissance Data Log

Forms of Ice		Topography		Type of Openings		Orientation of Opening		Stage of Melt	
x New Ice/nias	0 Pancake <3m	0 None	0 No Openings	0 None	0 No Melt	0 No Melt	0 No Melt	0 No Melt	0 No Melt
1 Brash <3m	1 New Ridge	1 Crack	1 No Openings	1 No Distinct	1 Few Puddles	1 Few Puddles	1 Few Puddles	1 Few Puddles	1 Few Puddles
2 Ice Cake 3-20m	2 Weathered ridge	2 Fracture 0.50m	2 Fracture 0.50m	2 NE-SW	2 Many Puddles	2 Many Puddles	2 Many Puddles	2 Many Puddles	2 Many Puddles
3 Small Floe 20-100m	3 Very Weathered ridge	3 Fracture 50-200m	3 Fracture 50-200m	3 E-W	3 Flooded	3 Flooded	3 Flooded	3 Flooded	3 Flooded
4 Medium Floe 100-500m	4 Aged ridge	4 Fracture 200-500m	4 Fracture 200-500m	4 SE-NW	4 Few Thawholes	4 Few Thawholes	4 Few Thawholes	4 Few Thawholes	4 Few Thawholes
5 Big Floe 500-2000m	5 Consolidated ridge	5 Fracture >500m	5 Fracture >500m	5 N-S	5 Many Thawholes	5 Many Thawholes	5 Many Thawholes	5 Many Thawholes	5 Many Thawholes
6 Giant Floe >10km	6 Vast Floe 2-10km	6 Lead	6 Lead	6 Parallels shore to E	6 Dried	6 Dried	6 Dried	6 Dried	6 Dried
7 Fast Ice/Floebergs	7 Rating	7 Polyrya	7 Polyrya	7 Parallels shore to S	7 Rotten	7 Rotten	7 Rotten	7 Rotten	7 Rotten
8 Unknown	8 Unknown	8 Water Between Floes	8 Water Between Floes	8 Parallels shore to W	8 Few Frozen Puddles	8 Few Frozen Puddles	8 Few Frozen Puddles	8 Few Frozen Puddles	8 Few Frozen Puddles
		9 Unknown	9 Unknown	9 Parallels shore to N	9 Retrozen Puddles	9 Retrozen Puddles	9 Retrozen Puddles	9 Retrozen Puddles	9 Retrozen Puddles

Date	Photo	Picture	Latitude	Longitude	Ground Speed (KTS)	Flight Level	Total Conc.	Second or Multi Year	Thick First Year	Partial Concentrations	Thin First Year	Young	New	Primary	Second	Extent	Topography	Primary Type	Second Type	Mean Ridge Height	Max Ridge Height	Openings	Orientation	Snow Cover	Stage of Melt	Comments
6/26/00	1010	7228N	6627W	195	190	9	7	7	7	2	2	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1015	7247N	6701W	6729W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1020	7305N	6729W	6800W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1025	7329N	6800W	6921W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1035	7420N	6921W	7002W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1040	7451N	6948W	7002W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1045	7448N	7002W	7011W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1050	7502N	7011W	6828W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1140	7400N	6828W	6740W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1145	7332N	6740W	6740W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1150	7309N	6740W	6632W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1155	7248N	6632W	6604W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1200	7230N	6604W	6400W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1210	7148N	6400W	6412W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1215	7132N	6412W	6434W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1220	7151N	6434W	6546W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1230	7231N	6546W	6614W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1235	7226N	6614W	6752W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1240	7319N	6752W	6752W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1245	7338N	6752W	6818W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1250	7400N	6818W	6854W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1255	7417N	6854W	6892W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1308	7438N	6892W	7002W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1305	7501N	7002W	7041W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1310	7524N	7041W	6942W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1315	7545N	6942W	6851W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1340	7526N	6851W	6816W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1345	7454N	6816W	6745W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1350	7432N	6745W	6708W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1355	7411N	6708W	6634W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1400	7348N	6634W	6552W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1405	7327N	6552W	6424W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1410	7284N	6424W	6349W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1415	7242N	6349W	6450W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1430	7141N	6450W	6527W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1445	7237N	6527W	6558W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1450	7300N	6558W	6634W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1455	7321N	6634W	6710W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1460	7343N	6710W	6753W	195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1465	7406N	6753W		195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	
1510	7434N	6753W		195	190	8	7	7	7	1	1	5	5	5	4	7	1	2	2	9	9	0	0	2	2	

# NIC Ice Reconnaissance Data Log

Form of Ice			Topography			Type of Openings			Orientation of Opening			Stage of Melt			Openings			Snow Cover			Comments					
New Features	1	2	3	4	5	6	7	8	9	0	No Distinct	1	2	3	4	5	6	7	8	9	0	7	40%			
1. Barren <5m	1	2	3	4	5	6	7	8	9	0	None	1	2	3	4	5	6	7	8	9	0	7	40%			
2. Ice Cliffs >20m	1	2	3	4	5	6	7	8	9	0	Fracture 0.50m	1	2	3	4	5	6	7	8	9	0	7	40%			
3. Small Flats 20-100m	1	2	3	4	5	6	7	8	9	0	Fracture 50-200m	1	2	3	4	5	6	7	8	9	0	7	40%			
4. Medium Flats 100-500m	1	2	3	4	5	6	7	8	9	0	Fracture 200-500m	1	2	3	4	5	6	7	8	9	0	7	40%			
5. Large Flats >500m	1	2	3	4	5	6	7	8	9	0	Fracture >500m	1	2	3	4	5	6	7	8	9	0	7	40%			
6. Coast Line <20km	1	2	3	4	5	6	7	8	9	0	Parallels strong to E	1	2	3	4	5	6	7	8	9	0	7	40%			
7. Coast Line >20km	1	2	3	4	5	6	7	8	9	0	Parallels strong to W	1	2	3	4	5	6	7	8	9	0	7	40%			
8. Fast Ice Flowlines	1	2	3	4	5	6	7	8	9	0	Parallels strong to N	1	2	3	4	5	6	7	8	9	0	7	40%			
9. Unknown	1	2	3	4	5	6	7	8	9	0	Unknown	1	2	3	4	5	6	7	8	9	0	7	40%			
Date	Time of Photo Obs	Picture File	Latitude	Longitude	Ground Speed (Kts)	Flight Level	Total Conc	Second or Third Year	Thick First Year	Medium First Year	Thin First Year	Young	New	Form of Ice	Second	Extent	Topography	Primary Type	Second Type	Mean Ridge Height	Max Ridge Height	Type	Orientation	Snow Cover	Stage of Melt	Comments
6/27/2000	8:30		7450N	16023W	200.225	4500	9		5	1			1	4	3	8	1	2	2	/	/	/	/	0	7	40%
	8:35		7410N	16043W	200.225	4500	8		5	3			1	5	3	4	1	2	2	/	/	/	/	0	7	40%
	8:40		7402N	16043W	200.225	4500	8		5	3			1	5	3	7	1	2	2	/	/	/	/	0	7	30%
	8:45		7344N	16016W	200.225	4500	7		5	2			1	5	3	7	1	2	2	/	/	/	/	0	7	40%
	8:50		7308N	16016W	200.225	4500	9		6	2			1	5	4	8	1	2	2	/	/	/	/	0	7	30%
	8:55		7250N	16043W	200.225	4500	9		7	2			1	5	4	8	1	2	2	/	/	/	/	0	7	30%
	9:00		7200N	16043W	200.225	4500	9		7	2			1	5	4	8	1	2	2	/	/	/	/	0	7	50%
	9:05		7250N	16013W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	50%
	9:10		7250N	16013W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	40%
	9:15		7250N	16013W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	40%
	9:20		7250N	16020W	200.225	4500	7		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	40%
	9:25		7250N	16020W	200.225	4500	7		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	40%
	9:30		7410N	16016W	200.225	4500	8		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	40%
	9:35		7410N	16016W	200.225	4500	8		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	40%
	9:40		7428N	16016W	200.225	4500	8		6	2			1	4	1	4	1	2	2	/	/	/	/	0	7	30%
	9:45		7458N	16039W	200.225	4500	8		5	2			1	4	1	4	1	2	2	/	/	/	/	0	7	40%
	9:50		7458N	16039W	200.225	4500	8		5	2			1	4	1	4	1	2	2	/	/	/	/	0	7	40%
	9:55		7458N	16039W	200.225	4500	8		5	2			1	4	1	4	1	2	2	/	/	/	/	0	7	40%
	10:00		7412N	16043W	200.225	4500	7		5	2			1	5	3	8	1	2	2	/	/	/	/	0	7	50%
	10:05		7358N	16020W	200.225	4500	7		5	2			1	5	3	8	1	2	2	/	/	/	/	0	7	50%
	10:10		7358N	16020W	200.225	4500	7		5	2			1	5	3	8	1	2	2	/	/	/	/	0	7	50%
	10:15		7358N	16020W	200.225	4500	8		6	2			1	5	3	8	1	2	2	/	/	/	/	0	7	50%
	10:20		7358N	16020W	200.225	4500	8		6	2			1	5	3	8	1	2	2	/	/	/	/	0	7	50%
	10:25		7258N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	10:30		7258N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	10:35		7313N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	10:40		7313N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	10:45		7324N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	10:50		7324N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	10:55		7324N	16027W	200.225	4500	8		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	50%
	11:00		7408N	16039W	200.225	4500	8		7	2			1	4	4	8	1	2	2	/	/	/	/	0	7	30%
	11:05		7422N	16039W	200.225	4500	8		7	2			1	4	4	8	1	2	2	/	/	/	/	0	7	30%
	11:10		7422N	16039W	200.225	4500	8		7	2			1	4	4	8	1	2	2	/	/	/	/	0	7	30%
	11:15		7422N	16043W	200.225	4500	7		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	30%
	11:20		7445N	16021W	200.225	4500	7		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	30%
	11:25		7445N	16021W	200.225	4500	7		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	30%
	11:30		7428N	16016W	200.225	4500	7		6	2			1	4	4	8	1	2	2	/	/	/	/	0	7	30%
	11:35		7411N	16028W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	50%
	11:40		7352N	16031W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	50%
	11:45		7310N	16031W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	40%
	11:50		7313N	16010W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	40%
	11:55		7155N	16030W	200.225	4500	9		7	2			1	5	4	8	1	2	2	/	/	/	/	0	7	60%
	12:00		7258N	16034W	200.225	4500	9		7	2			1	5	4	8	1	2	2	/	/	/	/	0	7	60%
	12:05		7421N	16010W	200.225	4500	9		7	2			1	5	4	8	1	2	2	/	/	/	/	0	7	60%
	12:10		7421N	16010W	200.225	4500	9		7	2			1	5	4	8	1	2	2	/	/	/	/	0	7	40%
	12:15		7458N	16013W	200.225	4500	6		5	3			1	5	3	5	1	2	2	/	/	/	/	0	7	40%
	12:20		7458N	16013W	200.225	4500	6		5	3			1	5	3	5	1	2	2	/	/	/	/	0	7	40%
	12:25		7457N	16027W	200.225	4500	6		5	3			1	5	3	5	1	2	2	/	/	/	/	0	7	30%
	12:30		7448N	16031W	200.225	4500	7		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	30%
	12:35		7458N	16031W	200.225	4500	7		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	30%
	12:40		7457N	16027W	200.225	4500	6		5	3			1	5	3	5	1	2	2	/	/	/	/	0	7	30%
	12:45		7448N	16031W	200.225	4500	7		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	30%
	12:50		7405N	16046W	200.225	4500	8		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	30%
	12:55		7405N	16046W	200.225	4500	8		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	30%
	13:00		7348N	16046W	200.225	4500	8		6	2			1	5	3	7	1	2	2	/	/	/	/	0	7	30%
	13:05		7331N	16015W	200.225	4500	5		5	1			1	4	3	7	1	2	2	/	/	/	/	0	7	40%
	13:10		7315N	16051W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	40%
	13:15		7258N	16051W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	40%
	13:20		7258N	16051W	200.225	4500	8		6	2			1	5	3	6	1	2	2	/	/	/	/	0	7	50%
	13:25		7113N	16042W	200.225	4500	8		6	2			1	5	4	8	1	2	2	/	/	/	/	0</		

# NIC Ice Reconnaissance Data Log

Forms of Ice									
New ice/melts									
0	None								
1	Pancake <3m								
2	Crack								
3	Weathered ridge								
4	Ice Cake 3-20m								
5	Small Flce 20-100m								
6	Medium Flce 100-500m								
7	Big Flce 500-2000m								
8	Vast Flce 2-10km								
9	Giant Flce >10km								
0	None								
1	New Ridge								
2	Weathered ridge								
3	Very Weathered ridge								
4	Aged ridge								
5	Consolidated ridge								
6	Vast Flce 2-10km								
7	Railing								
8	Unknown								
9	Unknown								
Type of Openings									
0	No Openings								
1	Crack								
2	Fracture 0-50m								
3	Fracture 50-200m								
4	Fracture 200-500m								
5	Fracture >500m								
6	Lead								
7	Polynga								
8	Recal Polynga								
9	Water Between Flies								
0	No Distinct								
1	NE-SW								
2	E-W								
3	SE-NW								
4	N-S								
5	Parallels shore to E								
6	Parallels shore to S								
7	Parallels shore to W								
8	Parallels shore to N								
9	Parallels shore to N								
0	No Melt								
1	Few Puddles								
2	Many Puddles								
3	Flooded								
4	Few Thawholes								
5	Many Thawholes								
6	Dried								
7	Rotten								
8	Few Frozen Puddles								
9	Refrozen Puddles								
0	Unknown								
1	Unknown								
Orientation of Opening									
0	No Distinct								
1	NE-SW								
2	E-W								
3	SE-NW								
4	N-S								
5	Parallels shore to E								
6	Parallels shore to S								
7	Parallels shore to W								
8	Parallels shore to N								
9	Parallels shore to N								
0	No Distinct								
1	NE-SW								
2	E-W								
3	SE-NW								
4	N-S								
5	Parallels shore to E								
6	Parallels shore to S								
7	Parallels shore to W								
8	Parallels shore to N								
9	Parallels shore to N								
Stage of Melt									
0	No Melt								
1	Few Puddles								
2	Many Puddles								
3	Flooded								
4	Few Thawholes								
5	Many Thawholes								
6	Dried								
7	Rotten								
8	Few Frozen Puddles								
9	Refrozen Puddles								
0	Unknown								
1	Unknown								
Form of Ice									
0	None								
1	Primary								
2	Second								
3	Extant								
4	4								
5	5								
6	6								
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9	9								
0	None								
1	Primary								
2	Second								
3	Extant								
4	4								
5	5								
6	6								
7	7								
8	8								
9	9								
0	None								
1	Primary								
2	Second								
3	Extant								
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13. ABSTRACT (Maximum 200 words) This flight report describes the field component of Meltpond2000, the first in a series of Arctic and Antarctic aircraft campaigns planned as part of NASA's Earth Observing System Aqua sea ice validation program for the Advanced Microwave Scanning Radiometer (AMSR-E). This prelaunch Arctic field campaign was carried out between June 25 and July 6, 2000 from Thule, Greenland, with the objective of quantifying the errors incurred by the AMSR-E sea ice algorithms resulting from the presence of melt ponds. A secondary objective of the mission was to develop a microwave capability to discriminate between melt ponds and seawater using low-frequency microwave radiometers. Meltpond2000 was a multiagency effort involving personnel from the Navy, NOAA, and NASA. The field component of the mission consisted of making five 8-hour flights from Thule Air Base with a Naval Air Warfare Center P-3 aircraft over portions of Baffin Bay and the Canadian Arctic. The aircraft sensors were provided and operated by the Microwave Radiometry Group of NOAA's Environmental Technology Laboratory. A Navy ice observer from the National Ice Center provided visual documentation of surface ice conditions during each of the flights. Two of the five flights were coordinated with Canadian scientists making surface measurements of melt ponds at an ice camp located near Resolute Bay, Canada. Coordination with the Canadians will provide additional information on surface characteristics and will be of great value in the interpretation of the aircraft and high-resolution satellite data sets.				
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	Forms of Ice	Topography	Type of Openings	Orientation of Opening	Stage of Melt
x	New ice/mass	0 None	0 No Openings	0 None	0 No Melt
1	Brash <1m	1 Weathered ridge	1 Crack	1 No Distinct	1 Few Puddles
2	Ice Cake <20m	3 Very Weathered ridge	2 Fracture 0-50m	2 E-W, S-W	2 Many Puddles
3	Small Floe 20-100m	4 Aged ridge	3 Fracture 50-200m	3 E-W, S-W	3 Flooded
4	Medium Floe 100-500m	5 Consolidated ridge	4 Fracture 200-500m	4 S-E-N-W	4 Few Thawholes
5	Large Floe 500m-2km	6 Vast Floe 2-10km	5 Fracture >500m	5 N-S	5 Many Thawholes
6	Small Floe <10km	7 Rifting	6 Lead	6 Parallels shore to E	6 Dried
7	Chart Floe >10km	8 Unknown	7 Polyrya	7 Parallels shore to E	7 Few Frozen Puddles
8	Fast ice/thawbergs	9 Unknown	8 Recur Polyrya	8 Parallels shore to W	8 Few Frozen Puddles
9	Unknown		9 Water Between Flocs	9 Parallels shore to N	9 Retrozen Puddles
10			Unknown	Unknown	10 Unknown

Date	Time of Photo Obs	Picture File	Latitude	Longitude	Ground Level (KTS)	Flight Level	Total Conc.	Partial Concentrations					Form of Ice		Topography		Openings		Snow Cover	Stage of Melt	Comments			
								Second or Multi-year	Thick First Year	Medium First Year	Thin First Year	Young	New	Primary	Second	Extent	Primary Type	Second Type				Mean Ridge Height	Max Ridge Height	Type
6/30/2003	933		74.22N	96.12W	192	1000	10	2	8				8		3	4	2	0	4	2	30%			
	940		74.40N	96.33W	192	1000	10	2	8				8		4	4	2	0	6	2	40%			
	945		74.40N	96.33W	192	1000	10	2	8				8		4	4	2	0	7	2	30%			
	950		75.08N	97.03W	192	1000	10	2	8				8		5	4	2	0	8	4	20%			
	955		75.08N	97.03W	192	1000	10	2	8				8		4	4	2	0	4	4	60%			
	1000		75.45N	97.00W	192	1000	10	3	9				8		5	4	2	0	0	0	40%			
	1005		75.52N	96.25W	192	1000	6	3	9				8		6	4	2	0	0	0	40%			
	1010		75.54N	96.18W	192	1000	5	4	5				4		4	4	2	0	9	7	2	40%		
	1015		75.48N	97.00W	192	1000	5	4	5				4		4	2	4	0	9	0	4	2	50%	
	1020		75.30N	97.02W	192	1000	10	1	8				4		3	4	2	0	4	2	60%			
	1030		75.00N	97.02W	192	1000	10	2	8				8		3	4	2	0	0	0	4	3	50%	
	1035		74.45N	97.10W	192	1000	10	3	7				8		4	4	2	0	0	0	4	3	60%	
	1040		74.56N	97.02W	192	1000	10	1	8				8		4	4	2	0	0	0	4	3	60%	
1045		75.12N	97.02W	192	1000	10	2	9				8		4	4	2	0	3	0	4	3	60%		
1050		75.31N	97.02W	192	1000	10	1	9				8		4	4	2	0	0	0	4	3	60%		
1055		75.49N	96.56W	192	1000	9	1	9				8		6	4	2	0	0	0	4	3	60%		
1060		75.49N	96.56W	192	1000	9	1	9				8		6	4	2	0	0	0	4	3	60%		
1100		75.59N	96.08W	192	1000	10	1	8				4		7	0	0	0	9	0	6	2	50%		
1105		76.01N	95.58W	192	1000	5	1	4				1		0	0	0	0	0	0	0	3	2	30%	
1110		75.58N	96.43W	192	1000	10	1	9				8		4	4	2	0	0	0	4	3	2	30%	
1115		75.58N	97.02W	192	1000	10	1	9				8		4	4	2	0	0	0	6	4	3	2	60%
1120		75.38N	97.02W	192	1000	10	1	9				8		5	4	2	0	8	5	4	3	60%		
1125		75.08N	97.02W	192	1000	10	1	10				8		5	4	2	0	0	4	3	60%			
1130		74.50N	97.02W	192	1000	10	1	9				8		5	4	2	0	0	5	3	50%			